PHYTOGEOGRAPHICAL RELATIONSHIPS OF THE GENERA OF ANGIOSPERMS IN THE FANJING SHAN MOUNTAIN RANGE, NORTHEASTERN GUIZHOU, CHINA[1]

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ABSTRACT

The Fanjing Shan mountain range, one of six *Man and the Biosphere (MAB) Preserves* in China, covers an area of ca. 567 km² in northeastern Guizhou Province, China. The flora comprises ca. 1,400 species of flowering plants in 636 genera, 23 of which are endemic to China or barely extend into bordering areas. The importance of the 20 largest families, which together contain more than half of the total species, is evaluated, and the phytogeographical affinities of the genera of angiosperms in the flora are analyzed and briefly discussed. In the Fanjing Shan region, tropical and temperate genera are nearly equally represented. The distributional patterns of the genera are analyzed, and some comparisons are made with eight other major mountain regions in south-central and southern China that also contain rich floras of phytogeographical significance. Fanjing Shan is most similar floristically to the Wuyi Shan, Jinfo Shan, and Shennongjia regions, areas to the north and east, than it is to any of the others, which, except for one, are located to the south and west. Besides the tropical and temperate components of the flora, the Fanjing Shan region also contains a rich representation of both Sino-Himalayan and Sino-Japanese elements.

China is particularly rich in numbers of plant species. The estimated 29,000 species of flowering plants and ferns within the country, including about 7,500 indigenous trees and shrubs (Pei, 1984), represent approximately 8–12% of all vascular plants known worldwide. Part of the richness can be accounted for by the diverse geology, complex climatic patterns, and broad altitudinal and latitudinal ranges. Elevational differences in China span more than 9,000 m from the summit of Qomolangma Feng (Mt. Everest) on the border with Nepal at 8,848 m above sea level to 154 m below sea level in the Turpan Depression in the Xinjiang Uygur Autonomous Region. China also occupies the only place on earth where an unbroken transition of vegetational types exists, ranging from tropical rainforests in the south through subtropical, temperate, and boreal forests, to tundra and alpine vegetation in China's southwest and north. This vegetational continuum has resulted in associations of plants not seen in other parts of the world and includes taxa with diverse and widespread phytogeographical relationships extending around the world. Many of the plants in these associations, or their ancestors, are among those considered to have had a much wider distribution during the Tertiary. Fieldwork in the Fanjing Shan mountain range in northeastern Guizhou by Chinese and American botanists in 1986, and fieldwork in other mountain ranges throughout China by Ying and his collab-

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orators, has provided the basis for interpreting the phytogeographical relationships of one particularly rich area, the Fanjing Shan mountain range, located between subtropical and temperate China.

Historical and Botanical Setting

Botanically, Guizhou is one of the least known provinces in China. The province, which occupies an area of about 174,000 km² and reaches from ca. 24°50′ to ca. 29°10′N and from ca. 103°46′ to 109°0′E, is located in a transitional position between the tropics in Guangxi and southern Yunnan and the subtropical and temperate areas of Hunan, Sichuan, and Hubei. The province also occupies a transitional position between the Sino-Himalayan flora, which extends from Yunnan through the Himalayas, and the Sino-Japanese flora of central and eastern China. As such, Guizhou is vital for the analysis and understanding of vegetational and floristic patterns and relationships in all of eastern Asia. Yunnan Province, one of only a few provinces in China for which more or less accurate figures are available, and which borders Guizhou on the west, is reported to contain ca. 14,000 species of flowering plants (Wu, 1984), or nearly half of all the angiosperms in China. Sichuan, to the north, is also considered to be floristically rich, but no accurate figures for the numbers of indigenous plants there are available. Similarly, Guizhou has a rich flora but, again, exact figures are not known.

Until relatively recent times Guizhou was one of the most backward and sparsely populated provinces in China (Geelan & Twitchett, 1974). It is largely mountainous with the major ranges in the north–central and south-central parts of the province. The highest peak, in the Fanjing Shan range in the Wuling Mountains, exceeds 2,550 m elevation (Deng, 1982). Extensive areas of flat land are scarce, and except for narrow areas along major streams, much of the land in cultivation has resulted from terracing. The two major roads in Guizhou roughly divide the province into quarters. One road runs from north to south through the center of the province and the other extends from Hunan Province in the east to Yunnan Province in the west. They intersect in the capital at Guiyang. Minor roads reach most other parts of the province, but travel in Guizhou has always been difficult because of the rugged terrain; even now travel by highway is slow, averaging only about 40 km per hour on the best highways. Because of these factors and the difficulties involved in exploiting the natural resources, the vegetation of Guizhou, although frequently heavily disturbed, is somewhat better preserved than in other parts of China. One exceptionally well conserved region in northeastern Guizhou, the Fanjing Shan mountain range, an area with an unusually rich assemblage of plants and animals, has been designated a *Man and the Biosphere Preserve.*

Few vegetational studies have been conducted in Guizhou. The first was a general discussion on the flora and vegetation of northeastern Guizhou based on observations made in the late summer and fall of 1931 during a collecting trip to the Fanjing Shan region (Steward & Chiao, 1933). Photographs published at the time show the vegetation to be more intact than at present, but signs of drastic disturbance are already evident in some of the photos.

The more recent and most important and extensive vegetational studies in Guizhou were also conducted in the Fanjing Shan mountain region and the findings published in *Scientific Survey of the Fanjingshan Mountain Preserve* by the Fanjingshan Mountain Preserve Institute (1982). Included in this publication are discussions on *Davidia involucrata* Baillon forests (Yang et al., 1982), *Quercus stewardiana* A. Camus (reported as *Cyclobalanopsis stewardiana* (A. Camus) K. M. Lan) forests (Yang, 1983), the general vegetation in the Fanjing Shan region (Huang et al., 1982a), a discussion of soils in the mountains (Zhang & Zhang, 1982), and geomorphology and recent crustal movements (Yang, 1982). Another paper by Huang et al. (1982b) discusses the newly described *Abies fanjingshanensis* W. L. Huang, Y. L. Tu & S. Z. Fang and its forest associations and phytogeographic relationships. The *Davidia* forests are composed of a mixture of deciduous trees with some broad-leaved evergreens and conifers at elevations between 1,000 and 1,800 m on the lower parts of moist slopes. These forests have been described as "complex," and from the descriptions are reminiscent of forests in which *Davidia* occurs in the Shennongjia Forest District in western Hubei Province (Bartholomew et al., 1983). The *Davidia* forests in the Fanjing Shan region have been considered so significant that they have been given government protection. The *Abies fanjingshanensis* forests are among the southernmost *Abies* forests in southeast Asia. According to Huang et al. (1982b) these forests, at 2,100–2,350 m elevation, were first discovered in 1981. The trees grow on north-, northwest-, and northeast-facing slopes with gradients of 50–60°. The species composition and community structure of these forests are somewhat similar to other *Abies* forests in southwest

China, but are reported to differ in a number of characteristics.

The occurrence of five species of *Fagus* L. in Guizhou Province (Guizhou Flora Committee, 1982) is of particular interest and is perhaps the greatest number of species of the genus growing in close proximity anywhere. Three of these species were the subject of investigation in the early 1970s by Tsien et al. (1975; see discussion below), who found that they form distinct forests on Fanjing Shan.

Guizhou is also located near the center of concentration in China of many eastern Asian–eastern North American disjunct genera. Among the taxa belonging to this association in the Fanjing Shan region are *Liriodendron* L. (Magnoliaceae), several species of *Asarum* L. sensu lato, whose affinities appear to be somewhat intermediate between *Asarum* sensu stricto and the eastern North American *Hexastylis* Raf. In the Polygonaceae are several species of *Polygonum* L. sect. *Echinocaulon* Meisner, a section with species in Asia and North America and one species, *P. sagittatum* L., attributed to the eastern part of both continents (Steward, 1930; Park, 1988). Another genus in the Polygonaceae, *Antenoron* Raf. (*Tovara* Adanson in many references), with two species reported for Guizhou, is also frequent and abundant in thickets, moist woods, and along streams. The number of species in the genus is questionable, and the relationship of the Asian taxa to each other and to the single North American species, *A. virginianum* (L.) Roberty & Vautier, is uncertain. Two species of *Liquidambar* L. occur in the Fanjing Shan area, *L. formosana* Hance and *L. acalycina* Chang. Small forests and individual trees of either or both of these two species are rather common in northeastern Guizhou. *Liquidambar acalycina* is considered to be closely related to the North American *L. styraciflua* L. and has been placed in the same section by Chang (1979).

Most recently, a treatment of the vegetation of the entire province has appeared (Huang et al., 1988). This work, which the authors state is aimed at university teachers and students, conservationists, geographers, ecologists, foresters, technicians, and farmers, discusses the physical environment, regionalization of the flora, and main vegetation types and their evolution, and utilization of the forest types in conjunction with farming, forestry, and animal husbandry.

Conservation

Conservation in China has recently been given high priority, and it is particularly noteworthy that the Fanjing Shan mountain range and forests have been designated a *Man and the Biosphere Preserve*. Unfortunately, however, habitat destruction is taking place at a rapid rate throughout China and even Fanjing Shan is not being spared. Trees around the margins of the preserve are actively being cut for conversion to charcoal, which is then transported several kilometers to villages at lower elevations, where it is sold. Other selected trees are being cut throughout much of the easily accessible parts of the preserve to build houses and for other construction purposes. The herbaceous flora suffers from the activities of overzealous diggers of medicinal plants who sell their harvests in all of the larger cities and towns surrounding Fanjing Shan. Tourism is being encouraged, and while most tourists remain close to the trails, their numbers are becoming so great that they are having a very definite and negative impact on many of the areas they visit. Their presence has become even more noticeable with the introduction and spread of nonbiodegradable food and beverage containers throughout China over the past few years. The lack of adequate sanitary facilities will undoubtedly have a deleterious effect on water resources. Unless these threats to the integrity of the area are addressed in the very near future, the Fanjing Shan region will ultimately resemble much of the rest of rural China, and many species of both plants and animals will be lost locally, if not completely.

Geographical Limits, Soil Types and Climate

The Fanjing Shan mountain range is generally known to include the highest peaks in Guizhou province. It is centered between 27°49′50″ and 28°1′30″N latitude and 108°45′55″ and 108°48′30″E longitude in northeastern Guizhou. The area is deeply cut on all sides by five deep, V-shaped valleys, resulting in a steep topography. The highest peak is about 2,570 m above sea level, and the relative elevation over the surrounding countryside ranges from 1,000 to 2,000 m. Four major soil types have been described in this region: (1) yellow-red earth, below 700 m; (2) yellow earth, (500–)700–1,400 m; (3) yellow-brown earth, 1,400–2,000 m; (4) mountain brown podzolic soil, above 2,200 m. All exhibit an acid reaction, with pH values lower than 5.0. Zhang & Zhang (1982) also reported a soil type, which they call a dark, mountain thicket soil, different from the mountain yellow brown earth and the soil in shrub meadows, in a zone between 2,000 and 2,300 m.

An analysis of the climatic features of the Fan-

jing Shan mountain area was made by Wang (1982), who classified the vertical climatic zones as middle subtropical, northern subtropical, southern temperate, and middle temperate.

On the basis of these floristic, vegetational, and environmental studies in the Fanjing Shan mountain range, we are now able to draw some conclusions on the relationships of its highly diverse and interesting flora and to discuss to some extent the phytogeography of an important segment of the Chinese flora.

Composition of the Vegetation in the Fanjing Shan Mountain Range

There are five forest zones from the base to the crest of the Fanjing Shan mountain range: (1) evergreen broad–leaved forest zone (below 1,300 m); (2) mixed evergreen-deciduous broad-leaved forest zone (1,300–1,900 m); (3) deciduous broad-leaved forest zone (1,900–2,100 m); (4) subalpine coniferous forest zone (2,100–2,350 m); and (5) subalpine shrub and meadow zone (above 2,350 m). The dominant genera in the forests are *Castanopsis* (D. Don) Spach, *Quercus* L., *Fagus*, *Acer* L., *Rhododendron* L., and the gymnosperm genera, *Tsuga* Carr. and *Abies* Miller, while the dominant members of the subalpine shrub-meadow zone are *Rhododendron* spp., *Sinarundinaria chungii* (Keng) P. C. Keng, and *Arundinaria fangiana* C. Camus. Because the zone occupied by the latter association is so narrow, it is not an important floristic component of the Fanjing Shan range. The distribution of the dominant species in the other zones is as follows.

Evergreen Broad-Leaved Forests

The dominant species of this forest type are *Castanopsis tibetana* Hance, *C. eyrei* (Champion) Tutcher, *C. fargesii* Franchet, *C. carlesii* Hayata, *Quercus stewardiana*, *Q. englergiana* Seemann, and *Q. dentata* Thunberg var. *oxyloba* Franchet. Almost all of the dominant species have distributions south of the Chang Jiang (Yangtze River) and are concentrated in central-southeastern China. *Castanopsis fargesii*, *C. carlesii*, and *C. eyrei* extend to Taiwan.

Deciduous Broad-Leaved Forests

The deciduous broad-leaved forests contain the primary portion of the Fanjing Shan flora. The dominant members of the forests are *Fagus lucida* Rehder & Wilson, *F. longipetiolata* Seemann, *F. engleriana* Seemann, and *Acer flabellatum* Rehder. The range of distribution of *Acer flabellatum* includes northeastern Yunnan, eastern Sichuan, western Hubei, northern Guangxi, northwestern Jiangxi, and Guizhou, an area where *Acer* is richly represented.

The three species of *Fagus* were the subject of investigation in the early 1970s by Tsien et al. (1975), who found that they form distinct forests on Fanjing Shan. Each of the species is segregated according to slope exposure, with *Fagus lucida* on west- and east-facing slopes, *F. engleriana* on north-facing slopes, and *F. longipetiolata* on south-facing slopes. Paleopalynological studies reveal that these *Fagus* communities have been in a continuous state of flux in response to changes in climatic conditions and that the three species have occupied various positions in relation to each other as climates differed in the past (Kong et al., 1977). The present distribution of these three species of *Fagus* in the Fanjing Shan region corresponds to their latitudinal distribution, where *F. longipetiolata* is a more southern species, *F. engleriana* is northern, and *F. lucida* is a more centrally distributed plant.

Subalpine Coniferous Forests

Among the important species in this forest type are *Tsuga forrestii* Downie, *T. longibracteata* Cheng, and *Abies fanjingshanensis*, with sporadically intermixed deciduous broad-leaved trees. Of the two species of *Tsuga*, one occurs in southern Sichuan, northwestern Yunnan, and western Hubei; the other extends from northeastern Guizhou through southern Hunan, northern Guangxi and Guangdong to Fujian. The distributional areas of these two species overlap in the Fanjing Shan and adjacent regions (Fig. 1). *Abies fanjingshanensis*, undoubtedly a relict species, is endemic to Fanjing Shan at elevations between 2,100 and 2,350 m. As with the examples mentioned above, we find that nearly all of the dominant species in the flora of Fanjing Shan are endemics concentrated in central and southeastern China.

Survey of Larger Families of Angiosperms

The largest families of flowering plants in the Fanjing Shan mountain range are the Rosaceae (66 species), Poaceae (54 species), and Fabaceae (51 species) (Table 1). The Rosaceae are a major family in this region and are very characteristic of the flora and vegetation of temperate areas in China. Poaceae and Fabaceae also exhibit an extraordinary frequency in forests and elsewhere in this

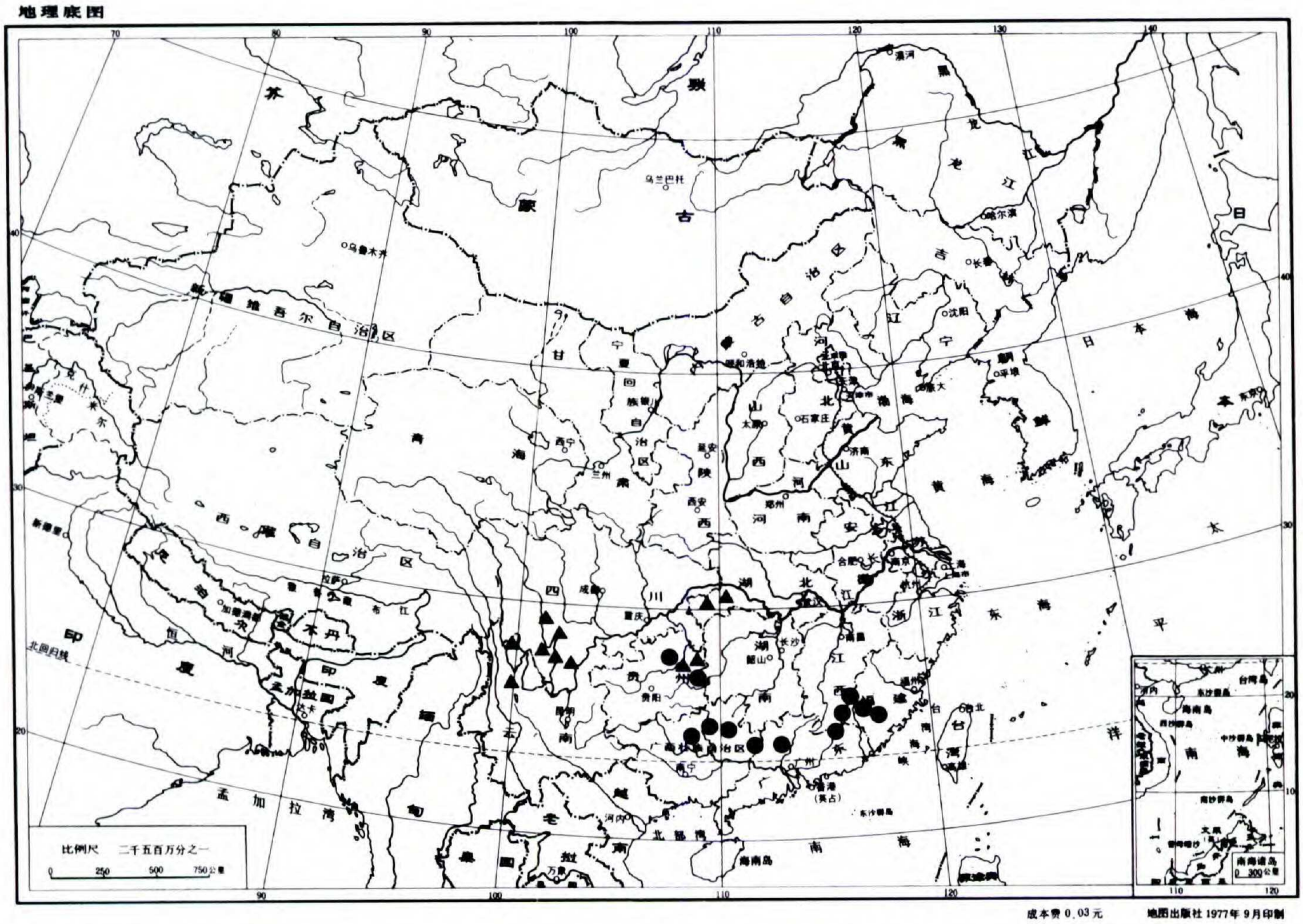

FIGURE 1. Distribution of *Tsuga forrestii* (▲) and *T. longibracteata* (●). Note overlap in their ranges in the Fanjing Shan region.

region. The development of the Fabaceae is mainly in the Papilionoideae, which has 41 species, while the Mimosoideae and Caesalpinioideae have only 2 and 8 species, respectively.

There are three families with between 40 and 50 species: the Liliaceae (48 species), Asteraceae (45 species), and Lauraceae (41 species). The Liliaceae and Orchidaceae form the major part of the wealth of the petaloid monocots, and together comprise nearly 9% of the total flora. The Lauraceae, with some 41 native species, comprise an important element of the flora. This family is tropical in nature, and even most genera in temperate regions have their distribution centers in tropical or subtropical locations.

There are five families with between 30 and 40 species. They are the Orchidaceae (38 species), Lamiaceae (36 species), Fagaceae (33 species). Cyperaceae (33 species), and Ericaceae (30 species). The 33 species in 6 genera in the Fagaceae are important elements in the flora. Many members of the family, especially species of *Castanopsis*, *Lithocarpus*, and *Quercus*, are the dominant forest species, and *Fagus*, with five species in China and three on Fanjing Shan, is centered and well developed in this region. Two families, the Ericaceae and Lamiaceae, are relatively poorly represented, but three genera of Lamiaceae endemic to China (*Bostrychanthera* Bentham, *Hanceola* Kudo, and *Rostrinucula* Kudo) occur here. The above 11 families comprise nearly 34.8% of the species of flowering plants in the Fanjing Shan flora.

There are nine families with between 20 and 30 species. In order of size they are: Ranunculaceae (29 species); Apiaceae (29 species); Theaceae (28 species); Saxifragaceae (28 species); Scrophulariaceae (24 species); Rubiaceae (24 species); Vitaceae (22 species); Caprifoliaceae (21 species); and Celastraceae (21 species). Except for the Theaceae, Rubiaceae, and Vitaceae, these families are north and south temperate, or only north temperate, in distribution.

The large number of archaic families in the flora of Fanjing Shan should also be mentioned. Their presence may be explained by the antiquity of the flora, although they are always represented by only one or a few species. The polycarpic Magnoliidae, generally considered to comprise the most primitive families and genera of flowering plants (Cronquist, 1981), are distributed mainly in eastern and southeastern Asia and in North, Central, and northern South America; there are 13 species in 8 genera

TABLE 1. Ranking of families in the Fanjing Shan flora based on numbers of species.

	Number of genera[1]	Number of genera endemic to China	Number of species[2]	Number of species endemic to China	
1. Rosaceae	14/48		66/855	51	
2. Poaceae	41/228		54/1,202	8	
3. Fabaceae	33/163		51/1,252	22	22.3%
4. Liliaceae	21/55		48/335	25	
5. Asteraceae	41/227	1	45/2,323	8	
6. Lauraceae	8/20		41/422	24	34.8%
7. Orchidaceae	29/165		38/998	13	
8. Lamiaceae	20/99	3	36/808	16	
9. Cyperaceae	9/31		33/668	6	
10. Fagaceae	6/6		33/281	22	
11. Ericaceae	7/14		30/718	21	
12. Ranunculaceae	12/40		29/736	14	
13. Apiaceae	15/95		29/525	11	
14. Theaceae	6/7		28/397	18	
15. Saxifragaceae	14/26		28/440	19	
16. Scrophulariaceae	12/60		24/634	10	
17. Rubiaceae	19/75	1	24/477	13	
18. Vitaceae	6/7		22/109	12	
19. Caprifoliaceae	5/12		21/207	17	
20. Celastraceae	5/13		21/184	12	
Total	322/1,398		701/13,571	342	
Percentages	50.2%		50.1%/46.73%	48.9%[3]	

[1] Number of genera in Fanjing Shan/number in China.
[2] Number of species in Fanjing Shan/number in China.
[3] Percentage of total species of larger families in Fanjing Shan region.

(*Illicium* L. (Illiciaceae) *Liriodendron* L., *Magnolia* L., *Manglietia* Blume, *Michelia* L. (Magnoliaceae), *Kadsura* Jussieu and *Schisandra* Michaux (Schisandraceae), and *Tetracentron* Oliver (Tetracentraceae)), in this category within the Fanjing Shan area. The Hamamelidaceae are also thought to be an archaic group; in the Fanjing Shan region the family is represented by 13 species in 6 genera. The main families of the old "Amentiferae," such as the Betulaceae, Fagaceae, Juglandaceae, Moraceae, Salicaceae, and Ulmaceae, are found on Fanjing Shan. In addition, three families endemic or nearly endemic to China, and also considered to be primitive or relictual, the Davidiaceae, Eucommiaceae, and Sargentodoxaceae (also in northern Laos and Vietnam), are also found here. The Fanjing Shan mountain range therefore harbors a great number of archaic or primitive taxa regardless of the criteria on which they are based.

The combined families mentioned above contain 701 species, or 51.1% of the total flora, and play an important role in shaping the characteristics of the forests of the Fanjing Shan mountain range.

RELATIONSHIPS OF THE FANJING SHAN FLORA

A. GEOGRAPHICAL AFFINITIES OF THE GENERA

The Fanjing Shan mountain range is very rich in genera of flowering plants, with 636, but is not especially rich in numbers of species, with only 1,431 (2.25 species per genus). Based on the geographical distribution given for each genus in Willis's (1973) *Dictionary of the Flowering Plants and Ferns* (eighth edition), and Mabberley's (1987) *The Plant-book*, and supplemented by information gathered from specimens in the herbaria at A, GH, HGAS (Guizhou Academy of Sciences), Guizhou Normal University, and PE, we were able to classify the genera of flowering plants in the Fanjing Shan preserve into 14 distribution types (Table 2) as follows.

1. Cosmopolitan genera

Some genera, mainly aquatics and mesophytes, are so widespread that they can be classified as

TABLE 2. Distribution types of genera of seed plants in the Fanjing Shan region.

Distribution type	Number of genera in the region	Percentage of all genera in the region	Number of species in the region	Percentage of all species in the region	Number of genera in China with this distribution pattern	Percentage of all genera in China with this distribution pattern
Cosmopolitan	56	8.8	162	11.3	107	52.3
Pantropic	109	17.1	291	20.3	373	29.2
Tropical America and tropical Asia	11	1.7	34	2.4	96	11.5
Old World tropics	36	5.7	63	4.4	162	22.2
Tropical Asia and tropical Australia	29	4.6	48	3.4	152	19.1
Tropical Asia and tropical Africa	23	3.6	31	2.2	160	14.1
Tropical Southeast Asia	60	9.4	114	8.0	570	10.5
North Temperate	112	17.6	332	23.2	297	37.7
Eastern Asia and North America	46	7.2	114	8.0	120	38.3
Old World Temperate	31	4.9	54	3.8	163	19.0
Temperate Asia	6	0.9	13	0.9	58	10.3
Mediterranean, western Asia and central Asia	1	0.2	1	0.07	169	0.6
Eastern Asia	93	14.6	149	10.4	294	31.6
Chinese endemics	23	3.6	25	1.7	214	10.7
Total	636	99.9	1,431	100.07	2,935	21.7

cosmopolitan. Fifty-six genera fall into this category. These taxa belong to 31 of the 143 native families in the Fanjing Shan region and include 162 species. These cosmopolitans comprise about 8.8% of the flora of Fanjing Shan, and 21.7% of the total families.

Many mesophytes such as *Senecio* L., *Aster* L., *Geranium* L., *Ranunculus* L., *Carex* L., *Polygonum* L., *Galium* L., and *Cyperus* L. are the dominant species of the herbaceous layer in forests and in montane grasslands. Because information derived from the distribution of cosmopolitan genera makes it impossible to determine the geographical affinities of the flora of the Fanjing Shan range, they are excluded from the statistical data.

2. Pantropical genera

Genera found in all three tropical regions (the Americas, Africa–Madagascar, Asia–Australasia) may be considered pantropical. A typical example is *Hypoxis* L. Other pantropical genera are concentrated in the tropics of one continent, but have few species in one or both of the other two regions. As an example, *Nertera* Banks & Solander ex Gaertner contains about 12 species, one common to New Zealand, South America, and Tristan da Cunha, one on Tristan da Cunha, one in Australia, one in Chile, one on Granada, two in the Philippines, one in south China, and eight in New Zealand (van Steenis, 1962; Wu & Li, 1965). Although the distribution of the genus might argue for the existence of *Nertera* before the breakup of the southern landmass, a more reasonable explanation is that members of the genus have been dispersed more recently by migrating birds that eat the berry fruits.

In the Fanjing Shan region 109 genera, or approximately 17.1% of the total genera (excluding the cosmopolitan ones), may be classified as pantropics. They contain about 291 species, which is 20.3% of all species in the flora of Fanjing Shan.

Of the 109 pantropical genera in Fanjing Shan, about 52 (47.7%) are herbaceous 42 (38.5%) are woody, 4 (3.7%) consist of lianas, and 11 others include both herbaceous and woody species. Although the distribution centers of these genera are primarily concentrated in the tropics of both hemispheres, a few of them, such as *Ilex* L., *Cynanchum* L., *Impatiens* L., *Buddleja* L., *Celastrus* L., *Cuscuta* L., *Euphorbia* L., *Indigofera* L., and *Grewia* L., extend to subtropical or even temperate regions.

3. Tropical America and tropical Asia

This distribution type is represented by proportionally few genera, especially when compared to those with a pantropical distribution. Only 11 genera in 10 families, representing only 1.7% of the total genera, are included in this category. These genera, all of which are woody, contain 34 species,

or 2.4% of the total flora of Fanjing Shan. In Australasia some of these genera may extend to northeast Australia or the southwest Pacific Islands, but their distribution centers are always limited to the American and Asian tropics. In China, several genera extend into temperate regions, e.g., *Picrasma* Blume, *Sageretia* Brongniart, and *Lindera* Thunberg, the latter to Liaoning province at lower elevations. All three, however, are concentrated in south-southwest China. Similar examples are found in *Litsea* Lamarck, but the genus attains its greatest diversity in southern and southwestern China, which has been considered to be its place of origin (Li, 1979). In North America, *Lindera* extends into the New England states and just reaches southern Canada; *Litsea* is found as far north as southeast Virginia and Tennessee. The American members of these two genera may not, therefore, be considered strictly tropical. These genera are common in the Fanjing Shan region and many of their species are the main constituents of the evergreen and deciduous broad-leaved forests.

4. *Old World tropics*

This distribution type is difficult to separate from the subtropical and sometimes even temperate pattern. We have segregated these genera mainly on the degree of their concentration in the tropics of the Old World. An example is *Dopatrium* Buchanan-Hamilton ex Bentham, which has about 12 species in the Old World tropics (Mabberley, 1987), but only one species, which extends as far north as Henan province, in China. Within the flora of Fanjing Shan, 36 genera (5.7%) may be classified as Old World tropical. Of these, 14 (38.9%) are woody, 14 (38.9%) are herbaceous, 3 (8.3%) are lianoid and 5 genera have both woody and herbaceous species. Among them, *Pittosporum* Banks ex Gaertner, *Albizia* Durazzini, and *Mallotus* Loureiro are constituents of broad-leaved forests, while others such as *Maesa* Forsskal and *Embelia* Burman f. are also rather common, but only in the shrub layers of the forests.

5. *Tropical Asia and tropical Australia*

In one sense this category is a subset of the Old World tropical pattern in that it includes genera with much the same kind of distribution, but with the main areas of concentration in the eastern and southeastern portion of the Old World tropics rather than in the west. The western extremity of this distribution type extends to Madagascar, but not to the African mainland. An example is found in *Balanophora* Forster & G. Forster in which 80 species occur in Australia, Polynesia, Malaysia, South China, Japan, and Madagascar, but none occur on the African continent.

Twenty-nine genera (4.6% of all genera) and 48 species (3.4% of all species) can be placed in this category. Among the genera, 10 are woody, 14 are herbaceous, and 5 are lianoid; only one genus (*Dunbaria* Wight & Arn.) has both woody and herbaceous species. The genus *Microcarpaea* R. Brown, with only one species, is a typical representative of this distribution type. In China these genera occur predominantly in southern China, but a few of them enter the temperate zone. Some, such as *Elaeocarpus* L., *Toona* (Endlicher) M. Roemer, *Wikstroemia* Endlicher, and *Nothopanax* Miquel, are important constituents of subtropical forests and shrublands. *Nothopanax* has a disjunct distribution in southwest China and New Zealand.

6. *Tropical Asia and tropical Africa*

This category is also a subcategory of the Old World tropical pattern in that it includes genera with much the same kind of distribution, but with their centers of concentration in the west and southwest rather than in the east. The eastern extremity of this distribution type extends to Fiji in the South Pacific, but not to Australia. A good example of this pattern is seen in *Lecanthus* Wedd., where three species occur in tropical Asia, one in tropical Africa, and one in Fiji, but none occur in Australia. A similar example is found in *Girardinia* Gaudichaud-Beaupre, which also extends into subtropical to temperate China. The genus *Crassocephalum* Moench contains 30 species, 29 of which are restricted to Africa and Madagascar, but one aggressive species occurs in eastern Asia.

In the Fanjing Shan region, 23 genera (3.6% of the total) belong to this distribution type. These genera contain 31 species (2.2% of the total species). Among the genera, 6 are woody, 10 are herbaceous, 3 are lianoid, and 4 contain both woody and herbaceous members. Except for *Debregeasia* Gaudichaud-Beaupre and *Miscanthus* Andersson, all of them are uncommon in this region. The monotypic genus *Toddalia* Jussieu is a typical representative of this distribution type.

7. *Tropical southeast Asia*

The Indo-Malesian region has one of the richest floras in the world. The eastern portion of the Indian region, and the northwestern portion of the Malesian region, through the Malay and Indochinese peninsulas, are very closely linked floristically with the mountains of south-central China.

Thus, a fairly large number of "typical" Indo-Malesian genera occur in south China. In the Fanjing Shan region, 60 of the 636 genera (9.4%) are included in this category. These genera contain about 114 species and constitute 8.0% of all the species in the flora. Among these 60 genera, 33 (55%) are woody, 17 (17%) are herbaceous, 6 (10%) are lianoid, and only 4 genera contain both woody and herbaceous species. Some of the woody genera, such as *Phoebe* Nees, *Machilus* Nees, *Neolitsea* (Bentham) Merrill, *Camellia* L., *Schima* Reinwardt ex Blume, and *Adinandra* Jack, *Daphniphyllum* Blume and *Carrierea* Franchet are the main constituents of evergreen, deciduous, and mixed broad-leaved forests in the Fanjing Shan area. *Ophiorrhiza* L. and *Dichroa* Loureiro are rather common in the herb and shrub layers of these forests.

8. North Temperate

Included under this heading are all the widely distributed genera restricted to the temperate regions of Eurasia and America. There are also a few genera that are equally characteristic of North Temperate areas and parts of the tropics, especially in the more mountainous regions of the latter. For example, the genus *Vaccinium* L. is widespread in temperate Eurasia and America, but some species extend into tropical regions of Asia and America, especially into tropical mountainous regions. Other examples are *Juglans* L., *Cotoneaster* Medikus, *Artemisia* L., *Rosa* L., *Thalictrum* L., and *Sambucus* L. In the Fanjing Shan area the genera belonging to this category total 112, or 17.6% of the total genera enumerated. They represent the highest proportion of distribution types in the flora of Fanjing Shan. These genera contain over 330 species, nearly 25% of all species in this area. Among them are 42 woody and 64 herbaceous genera, 8 genera with both woody and herbaceous species, and only 1 lianoid genus.

This category forms the nucleus of the flora of the Fanjing Shan mountain range. Among the especially prominent and significant genera in terms of their dominance in the vegetation of the region are *Acer*, *Fagus*, *Betula* L., *Carpinus* L., *Alnus* Miller, *Cornus* L., *Castanea* Miller, *Juglans*, *Sorbus* L., *Prunus* L., *Tilia* L., *Rhododendron*, *Ilex*, and *Fraxinus* L. Most of these genera contain only deciduous trees and all of them are typical North Temperate genera. Within this category, however, 17 of the 112 genera occur disjunctly in both North Temperate and South Temperate regions, while *Coriaria* L., a common shrub genus, shows a discontinuous distribution in the Mediterranean area, eastern Asia from the Himalayas to Japan, New Zealand, Mexico, and Chile.

9. Eastern Asia and North America

Among North Temperate disjunction patterns, the one between eastern Asia and North America is perhaps the most important biogeographically for the amount of interest it has generated. It has been one of the best known since Asa Gray (1846) first drew special attention to it, and it has been much studied and discussed (Boufford & Spongberg, 1983; Graham, 1972a, b; Hara, 1952, 1956, 1972; Hu, 1935, 1936; Li, 1952; Wu, 1983).

In the flora of Fanjing Shan 46 genera, which represent 7.2% of the total genera, belong to this distribution type. These genera contain 114 species, or 8.0% of all species in the region. Among these genera, 23 (50% of this distribution type) are woody, 17 (37%) are herbaceous, 4 (8.7%) are lianoid, and only 2 genera (4.3%) have both woody and herbaceous species. Although genera with this distribution pattern are concentrated in eastern Asia and North America, some of them (such as *Itea* L., *Nyssa* L., *Castanopsis*, and *Lithocarpus*) extend into the Indo-Malesian region, or occasionally even into Central Asia (*Veronicastrum* Moench), or Australia (*Lespedeza* Michaux) in the Old World, and into tropical regions in the New World (*Catalpa* Scopoli, *Muhlenbergia* Schreber, and *Illicium*). *Tsuga* and *Castanopsis* are important constituents of hemlock forests and broad-leaved evergreen forests, respectively. *Lithocarpus*, *Liquidambar*, *Hydrangea* L., *Illicium*, *Sassafras* Nees & Ebermaier, *Photinia* Lindley, and *Aralia* L. are also major constituents of evergreen and broad-leaved deciduous forests in this region. Two additional genera, *Abelia* R. Brown and *Cleyera* Thunberg, are also rather common; they are disjunctly distributed in eastern Asia and Mexico.

10. Old World Temperate

Discussed here are genera widely distributed over the North Temperate Zone of the Old World. At both ends of their range, and more especially in the west, many of these genera, such as *Dipsacus* L., *Inula* L., *Lactuca* L., *Lotus* L., *Oenanthe* L., and *Peucedanum* L., often show a tendency to extend southward into Africa. Two additional genera, *Ligustrum* L. and *Daphne* L., although they range throughout the Old World Temperate Zone, may also be mentioned here because, respectively, they also have one or a few species in Australia and in the Indo-Malesian region.

In the flora of Fanjing Shan, 31 genera, or 4.9% of all genera, belong to this distribution type. These

genera contain 54 species, or about 3.8% of the total. Among the genera, 6 are woody, 22 are herbaceous, and only 3 have both woody and herbaceous members. The woody genera are not the main constituents of the forests of Fanjing Shan, but the herbaceous genera are the main constituents of the montane grasslands or of the herb layers of the forest.

11. Temperate Asia

This type is represented by proportionally few genera, especially when compared with the North Temperate type. Included here are all the genera mainly distributed in Temperate Asia. Their distributional areas sometimes extend southward to the more elevated regions of the subtropical zone. For example, *Campylotropis* Bunge (Fabaceae) contains about 45 species, of which 29 are distributed in China, and almost all of which are concentrated in the subtropical regions of the country (Fu, 1987). These species show their temperate nature, however, in their ecologically restricted occurrence to areas with elevations between 1,000 and 3,000 m. We have segregated this group of genera mainly on the basis of the ecological preference of their subtropical representatives.

In the flora of Fanjing Shan this distribution type is represented by only 6 genera, or 0.9% of all genera. Together they contain about 13 species, which comprise only 0.9% of all species. With the exception of one woody genus, *Campylotropis*, all are herbaceous.

12. Mediterranean, western Asia to central Asia and China; North America to Central America

In the flora of Fanjing Shan, only *Pistacia* L. belongs to this distribution type.

13. Eastern Asia

This category is a large one calculated to contain about 93 genera (14.6% of the total) and is rather difficult to distinguish from the temperate Asian distribution type. The genera occupy smaller ranges and are essentially distributed in China and Japan.

These genera can be roughly divided into three subgroups based on their distribution centers in relation to Guizhou. One includes genera extending from the Himalayan region across China to Japan; the other two subgroups have eccentric distribution centers, either westward or northeastward. Members with a westward distribution show a Sino-Himalayan range, from China to the Himalayas; the northeastward group shows a Sino-Japanese pattern, from China to Japan. Among the primarily Eastern Asian genera, about one-fifth belong to the Sino-Himalayan-Japan subgroup, one-fifth to the Sino-Himalayan subgroup, and three-fifths to the Sino-Japanese subgroup. These genera sometimes extend southward into Burma, Indochina, and/or the Malay Archipelago.

Among the genera distributed from the Himalayan region to Japan are: *Choerospondias* B. L. Burtt & A. W. Hill, *Dichocarpum* W. T. Wang & Hsiao, *Hovenia* Thunberg, *Neillia* D. Don, *Houttuynia* Thunberg, *Euscaphis* Siebold & Zuccarini, *Pterostyrax* Siebold & Zuccarini, *Liriope* Loureiro, *Boenninghausenia* Reichenbach ex Meisner, and *Helwingia* Willdenow.

Of the 93 genera in this category in the flora of Fanjing Shan (14.6% of the total genera), 47 are herbaceous, 38 are woody, and 8 are lianoid. The woody genera, such as *Cercidiphyllum* Siebold & Zuccarini, *Acanthopanax* (Decaisne & Planchon) Miquel, *Dendrobenthamia* Hutchinson (= *Cornus* L. subg. *Syncarpea* (Nakai) Q. Y. Xiang), *Enkianthus* Loureiro, *Idesia* Maximowicz, *Platycarya* Siebold & Zuccarini, *Pterocarya* Kunth, and *Tetracentron* Oliver, are important constituents of the broad-leaved forests, while the herbaceous genera, such as *Ophiopogon* Ker-Gawler, *Liriope*, *Reineckea* Kunth, *Tripterospermum* Blume, and *Ainsliaea* DC., play an important role in the herb layer of the same forests. *Sinarundinaria* Nakai is the main constituent under trees in the broad-leaved deciduous forests and in subalpine scrublands.

14. Endemic genera

For the Fanjing Shan mountain range as a whole, 23 of the 636 native genera (3.6%) are endemic to China, but all of them are shared with other provinces. These endemic genera are listed with their ranges and number of species in Table 3. Twelve of these genera are monotypic and nine are oligotypic; the two remaining genera have multiple species. Among the 23 are 11 arborescent genera, of which nine are deciduous and two are evergreen. Eleven genera are herbaceous and only one, *Clematoclethra* Maxim., is lianoid. Except for three genera, *Eurycorymbus* Handel-Mazzetti (Sapindaceae: 1 species), *Dysosma* Woodson (Berberidaceae: 7 species), and *Cunninghamia* R. Brown (Taxodiaceae: 2 species), which occur in Taiwan, all are restricted to central and southeastern China.

Based on the figures cited above we were able to conclude that among the native genera in the flora of Fanjing Shan, 268 (42.1%) are tropical,

TABLE 3. Chinese endemic or near endemic genera in the flora of Fanjing Shan with overall distribution of the genus. The second column indicates the number of species in Fanjing shan/number of species in China.

Asteropyrum (Ranunculaceae)	1/2	Guangxi, Guizhou, Hubei, Hunan, Sichuan, Yunnan.
Bretschneidera (Bretschneideraceae)	1/1	Guangdong, Guangxi, Guizhou, Hunan, Jiangxi, Sichuan, Taiwan, E Yunnan, Zhejiang.
Bostrychanthera (Lamiaceae)	1/1	Fujian, Guangdong, Guangxi, Guizhou, Hubei, Sichuan, Taiwan.
Chimonanthus (Calycanthaceae)	1/2	Anhui, Fujian, Gansu, Guangxi, Guizhou, Henan, Hubei, Hunan, Jiangsu, Jiangxi, Shaanxi, Sichuan.
Camptotheca (Nyssaceae)	1/1	Fujian, Hubei, Hunan, Guangdong, Guangxi, Guizhou, Jiangxi, Sichuan.
Clematoclethera (Actinidiaceae)	1/4	Guizhou, Hubei, Shaanxi, Sichuan, Yunnan
Cyclocarya (Juglandaceae)	1/1	Anhui, Fujian, Guangdong, Guangxi, Guizhou, Hubei, Hunan, Jiangxi, Sichuan, Zhejiang.
Cunninghamia (Taxodiaceae)	1/2	South of the Qinling range.
Davidia (Nyssasaceae)	1/1	Guizhou, Hubei, Sichuan, N Yunnan.
Dysosma (Berberidaceae)	3/7	South of the Qinling range.
Dickinsia (Apiaceae)	1/1	Guizhou, Hubei, Hunan, Sichuan, Yunnan.
Dipteronia (Aceraceae)	1/2	S Gansu, Guizhou, Henan, W Hubei, Shaanxi, Sichuan, SE Yunnan.
Eucommia (Eucommiaceae)	1/1	E to SW China.
Eomecon (Papaveraceae)	1/1	Fujian, Guangxi, Guizhou, Hubei, Hunan, Jiangxi, Sichuan.
Emmenopterys (Rubiaceae)	1/1	E to SW China (and India).
Eurycorymbus (Sapindaceae)	1/1	S and SW China, Taiwan.
Hanceola (Lamiaceae)	1/8	Guangxi, Guizhou, Hunan, Sichuan, Yunnan.
Latouchea (Gentianaceae)	1/1	Fujian, Guangdong, Guizhou.
Pteroceltis (Ulmaceae)	1/1	N to S and SW China.
Rostrinucula (Lamiaceae)	1/2	Guangxi, Guizhou, Hubei, Hunan, Shaanxi, Sichuan, Yunnan.
Sinojohnstonia (Boraginaceae)	1/3	Guizhou, Hubei, Jiangxi, Shaanxi, Sichuan, Zhejiang.
Thyrocarpus (Boraginaceae)	1/3	Anhui, Fujian, Guangdong, Guangxi, Guizhou, Hubei, S Jiangsu, Jiangxi, E Yunnan.
Whytockia (Gesneriaceae)	1/3	Guizhou, Taiwan, SE Yunnan.

289 (45.4%) are temperate, and 23 (3.6%) are Chinese endemic genera. It is clear in the numbers and percentages that tropical and temperate genera are of about equal importance in the flora of Fanjing Shan. Taking a more general view, however, and looking for ultimate sources, it appears that the flora of Fanjing Shan can be thought of as comprising two main elements, a northern and a southern one, disbursed, as would be expected, along an altitudinal gradient in five vegetational zones (as discussed above).

B. RELATIONSHIPS WITH OTHER MOUNTAINOUS REGIONS IN CHINA

To determine the area's floristic affinities within China, eight mountainous regions in the central and south-central part of the country (Fig. 2) were selected for comparison with the Fanjing Shan region. Based on the worldwide distribution of the genera in the nine mountain regions, 15 distribution patterns can be recognized (Table 4). As expected, temperate genera increase and tropical genera decrease in numbers with increasing latitude. Fanjing Shan, with 268 tropical and 289 temperate genera (excluding the Chinese endemic genera), has about an equal representation of temperate and tropical elements. Taibai Shan, located to the north of Fanjing Shan in Shaanxi province, has 397 (68.0%) temperate and 105 (18.0%) tropical genera; cosmopolitan genera (60, or 10.2%) and endemic genera (22, or 3.8%) make up the remaining 14%. Wuzhi Shan has the highest proportion of tropical genera (88.8%) of any of the areas examined, which would be expected from its southerly location on Hainan Island at about 19°N latitude. The numbers of shared genera and the coefficients of similarity between these mountainous regions are given in Table 5. The higher coefficients of similarity between the Fanjing Shan region (A) and Wuyi Shan (B) (52.8%), the Fanjing Shan region and Shennongjia (D) (50.6%), and the Fanjing Shan region and Jinfo Shan (C) (50.7%) indicate closer phytogeographical links between those four areas

TABLE 4. The principal distribution types of the genera in the floras of nine mountain regions of China. CA = central Asia; COS = cosmopolitan; EA = eastern Asia; EN = endemic; ENA = eastern Asia–North America; MWC = Mediterranean–western and central Asia; NT = North Temperate; OT = Old World tropical; OTE = Old World temperate; PAN = pantropical; TA temperate Asia; TAA = tropical Asia and tropical America; TAF = Tropical Asia and tropical Africa; TAU = tropical Asia and tropical Australia; TSE = tropical Southeast Asia.

Mountain region	Tropical genera								Temperate genera									Total all genera	Area km²
	COS	PAN	TAA	OT	TAU	TAF	TSE	Total	NT	ENA	OTE	TA	MWC	CA	EA	Total	EN		
Fanjing Shan	56	109	11	36	29	23	60	268	115	46	32	6	2	—	91	289	23	636	567
Jinfo Shan	44	77	13	18	12	13	41	174	112	44	32	4	1	—	78	271	26	515	280
Miaoer Shan	43	106	11	35	20	13	66	251	60	34	17	3	—	—	66	180	17	491	267
Nanjiabawa	71	140	20	51	40	41	124	416	183	48	55	14	13	7	124	444	24	955	9,400
Shennongjia	61	121	12	28	22	19	40	242	163	64	52	16	5	—	121	421	47	771	3,250
Taibai Shan	60	63	4	10	6	10	12	105	173	45	73	16	5	4	81	397	22	584	2,379
Wuyi Shan	58	140	13	41	31	28	63	316	101	48	29	5	1	—	91	275	16	665	500
Wuzhi Shan	41	215	22	87	82	55	195	656	28	17	7	1	1	—	29	83	6	786	?
Yulongxue Shan	63	87	4	19	10	23	17	160	155	31	55	14	9	5	62	331	16	570	455

TABLE 5. Degree of similarity of nine major mountain regions in China. Number of shared genera/coefficient of similarity.

		A	B	C	D	E	F	G	H	I
A	Fanjing Shan	—								
B	Wuyi Shan	412/52.8	—							
C	Jinfo Shan	350/50.7	309/41.0	—						
D	Shennongjia	435/50.6	418/46.4	368/46.2	—					
E	Miaoer Shan	330/46.9	343/48.2	313/37.0	251/38.5	—				
F	Nanjiabawa	386/35.6	361/31.9	403/33.8	302/29.1	272/25.7	—			
G	Taibai Shan	289/35.2	259/29.7	374/43.5	253/34.8	174/21.8	341/32.0	—		
H	Yulongxue Shan	272/32.9	241/27.0	326/36.4	222/29.8	187/24.2	340/36.2	270/35.2	—	
I	Wuzhi Shan	254/23.6	293/27.7	237/19.5	160/15.4	309/32.9	234/32.9	113/9.8	141/12.6	—

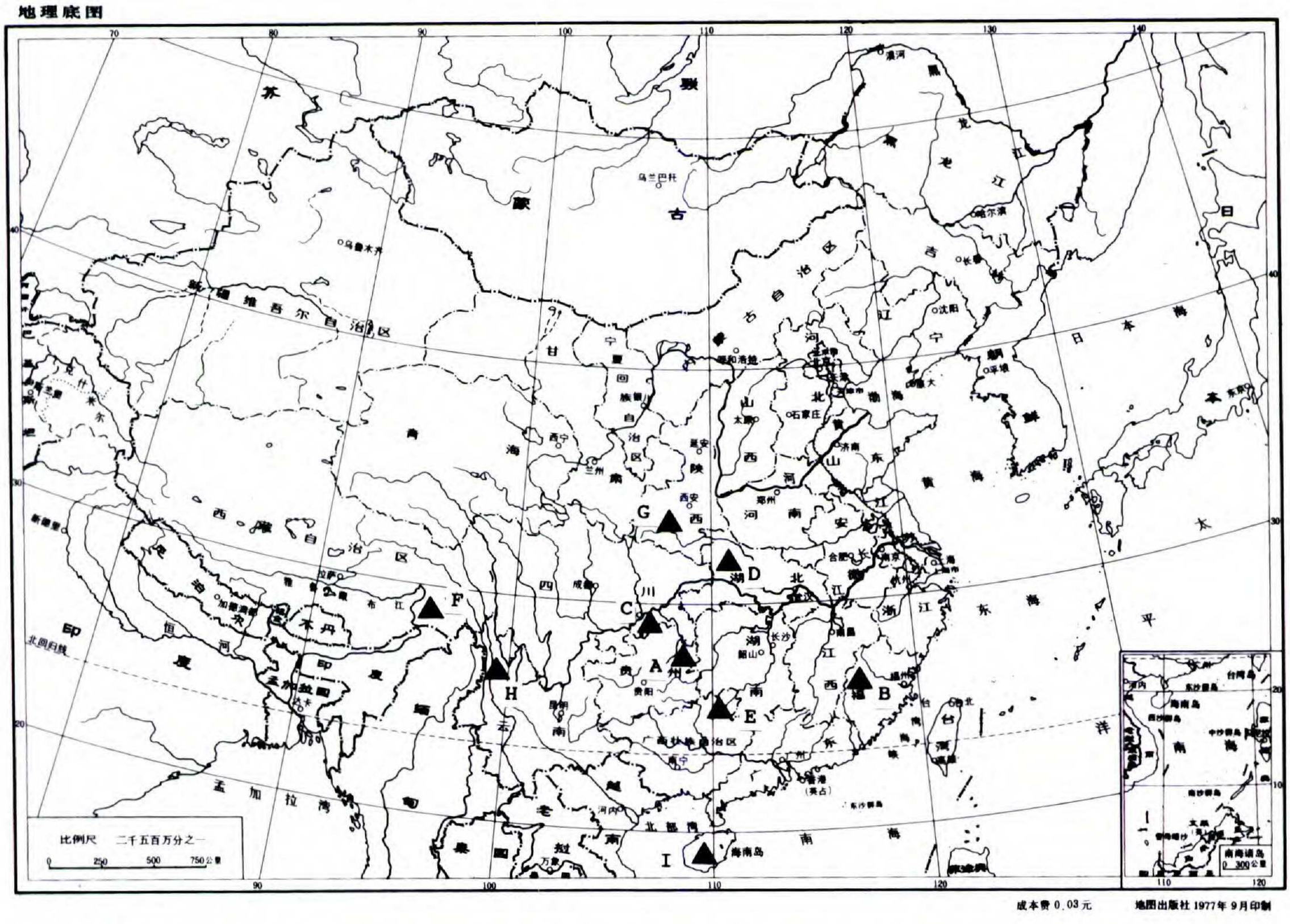

FIGURE 2. Map of China showing location of Fanjing Shan and eight major mountainous regions with which its flora is compared.—A. Fanjing Shan.—B. Wuyi Shan.—C. Jinfo Shan.—D. Shennongjia.—E. Miaoer Shan.—F. Nanjiabawa.—G. Taibai Shan.—H. Yulongxue Shan.—I. Wuzhi Shan.

than between Fanjing Shan and any of the other regions. The significance of the coefficient of similarity between Fanjing Shan and Wuyi Shan on the Fujian-Jiangxi border in eastern China is remarkable because these two ranges are nearly twice as far apart as Fanjing Shan is from either Miaoer Shan (E) in northeastern Guangxi or Jinfo Shan (in southeastern Sichuan), and about 25% farther apart than Fanjing Shan and the Shennongjia region. Noteworthy, however, are the especially low coefficients of similarity between Fanjing Shan and Nanjiabawa (F) in Xizang (Tibet), Taibai Shan (G) in the Qinling Mountains in southern Shaanxi, Yulongxue Shan (H) in northwestern Yunnan and Wuzhi Shan (I) on Hainan, and the clear contrast between regions A to E and regions F to I. The second column in Table 5 shows that the coefficients of similarity between regions B, C, D, and E are still higher than they are with any of the other areas. The coefficients of similarity between I and G (9.8%) and I and H (12.6%) are surprisingly low, attesting to the uniqueness of the Wuzhi Shan flora.

A comparison of the degrees of similarities with nine mountainous regions in China, based on the distribution of genera, shows that the floristic affinities of Fanjing Shan are with Wuyi Shan in southeastern China and secondarily with Jinfo Shan and the Shennongjia region in central China. Phytogeographically, the Fanjing Shan region is transitional between the Sino-Himalayan and Sino-Japanese floras and contains an almost equal number of temperate and tropical genera.

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APPENDIX. Genera in the Fanjing Shan flora and their worldwide distribution. Number of species (approximately): Fanjing Shan/China/worldwide.

1. COSMOPOLITAN	
Amaranthus L.	1/13/40
Anemone L.	3/52/150
Apium L.	1/1/1
Aster L.	2/130/500
Astragalus L.	1/130/2,000
Bidens L.	1/8/230
Carex L.	19/400/1,500–2,000
Clematis L.	10/110/250
Cyperus L.	2/30/550
Digitaria Haller	1/20/380
Eleocharis R. Br.	2/25/200
Eragrostis Wolf	1/35/300
Erigeron L.	1/33/200
Galium L.	1/50/400
Gentiana L.	1/250/500
Geranium L.	2/65/400
Goodyera R. Br.	3/15/40
Hippuris L.	1/1/2–3
Hydrocotyle L.	3/15/75
Hypericum L.	8/55/370
Juncus L.	3/65/300
Lemna L.	1/3/15
Lobelia L.	1/20/250
Lysimachia L.	6/90/200
Mimulus L.	2/5/100
Nymphoides Hill	1/6/20
Oxalis L.	2/10/800
Panicum L.	1/20/500
Physalis L.	1/5/100
Pimpinella L.	2/40/150
Plantago L.	1/16/265
Polygala L.	4/40/500–600
Polygonum L.	12/120/300
Potamogeton L.	1/30/100
Pycreus Pal.	2/10/100
Ranunculus L.	3/90/400
Rhamnus L.	4/59/160
Rorippa Scop.	1/9/70
Rubus L.	26/280/600
Rumex L.	3/30/200
Sagittaria L.	2/6/20
Salvia L.	3/84/700
Sanicula L.	3/22/37
Scirpus L.	1/37/300
Scutellaria L.	1/98/300
Senecio L.	2/160/2,000
Solanum L.	4/39/1,700
Sophora L.	1/23/50
Spirodela Schleiden	1/2/6
Stachys L.	1/18/300
Stellaria L.	1/57/120
Swertia L.	1/50/100
Teucrium L.	2/18/300
Utricularia L.	1/17/120
Viola L.	5/120?/500
Xanthium L.	1/5/30
2. PANTROPICAL GENERA	
Achyranthes L.	3/3/15
Adenostemma Forst. & G. Forst.	1/2/20
Alchornea Sw.	1/6/70
Ardisia Sw.	7/69/400
Aristolochia L.	1/51/300
Arundinella Raddi.	1/11/55
Arundo L.	1/3/12
Bauhinia L.	2/35/300
Begonia L.	2/90/900
Boehmeria Jacq.	8/35/50
Brachiaria Griseb.	1/6/90
Buddleja L.	4/45/100
Bulbophyllum Thouars.	1/36/1,200
Bulbostylis Kunth	1/3/100
Caesalpinia L.	2/16/100
Calanthe R. Br.	4/40/120
Callicarpa L.	5/42/140
Calystegia R. Br.	1/6/25
Cassia L.	2/22/550
Celastrus L.	3/20/35
Celosia L.	1/3/60
Celtis L.	3/20/60
Centipeda Lour.	1/1/6
Cissus L.	1/11/350
Clerodendrum L.	3/30/400
Cocculus DC.	1/2/11
Commelina L.	1/7/100
Conyza Less.	1/8/50
Corchorus L.	1/3/100
Crotalaria L.	6/34/600
Cuscuta L.	2/10/170
Cynanchum L.	4/52/200
Cynodon Rich.	1/2/10
Dalbergia L. f.	2/25/100
Dendropanax Decne. & Planchon	1/16/30
Derris Lour.	1/20/40
Desmodium Desv.	2/55/350
Dioscorea L.	6/49/600
Diospyros L.	5/56/500
Dolichos L.	1/7/70
Eclipta L.	1/1/3–4
Eleusine Gaertner	1/2/10
Erianthus Michaux	1/8/30
Eriocaulon L.	3/45/400
Erythroxylum P. Browne	1/2/250
Euonymus L.	14/90/175
Eupatorium L. s.l.	1/15/1,200
Euphorbia L. s.l.	2/60/2,000
Ficus L.	10/120/800
Fimbristylis Vahl	14/47/200

APPENDIX. Continued.

Gleditsia L.	3/6/16
Glochidion Forst. & G. Forst.	2/25/300
Gouania Jacq.	1/2/20
Haloragis Forst. & G. Forst.	1/2/26
Hibiscus L.	2/24/200
Hypoxis L.	1/1/100
Ilex L.	17/118/400
Impatiens L.	14/190/850
Indigofera L.	3/70/700
Ipomoea L.	1/25/500
Isachne R. Br.	3/15/75
Ischaemum L.	1/15/50
Jasminum L.	1/44/300
Kyllinga Rottb.	1/6/60
Laportea Gaudich.	2/16/23
Lasianthus Jack.	4/32/180
Leersia Sw.	1/4/15
Lindernia All.	3/26/100
Lycianthes Hassler	1/9/200
Mariscus Vahl	1/7/200
Millettia Wight & Arn.	4/30/180
Morinda L.	1/8/80
Murdannia Royle	3/18/50
Nertera Banks & Sol. ex Gaertner	1/1/12
Oplismenus Pal.	1/3/15
Ormosia Jackson	1/35/120
Ottelia Pers.	1/8/40
Paspalum L.	1/10/250
Pennisetum Rich. ex Pers.	1/8/70
Perrottetia Kunth	1/3/20
Phaseolus L.	1/15/50
Phytolacca L.	1/4/35
Pilea Lindley	6/65/400
Piper L.	1/35/2,000
Pouzolzia Gaudich.	1/5/50
Pratia Gaudich.	1/3/35
Psychotria L.	1/15/700
Rapanea Aublet	2/7/200
Sacciolepis Nash	1/3/30
Sapium P. Browne	2/9/120
Schefflera Forst. & G. Forst.	2/37/200
Schoepfia Schreber	1/3/25
Setaria Pal.	4/17/140
Siegesbeckia L.	2/3/6
Smilax L.	11/61/300
Sporobolus R. Br.	1/6/150
Styrax L.	4/55/130
Symplocos Jacq.	11/125/350
Ternstroemia Mutis ex L. f.	1/20/100
Torenia L.	2/11/50
Trema Lour.	2/6/30

APPENDIX. Continued.

Triumfetta L.	1/8/150
Uncaria Schreber	1/13/60
Urena L.	1/4/6
Verbena L.	1/1/250
Vitex L.	1/20/250
Wahlenbergia Schrader ex Roth.	1/1/150
Zanthoxylum L.	5/50/250
Zizyphus Miller	1/13/100

3. TROPICAL AMERICA AND TROPICAL ASIA

Clethra L.	4/16/70
Gaultheria L.	1/26/210
Lindera Thunb.	8/54/100
Litsea Lam.	7/64/400
Meliosma Blume	4/10/25
Microtropis Wallich ex Meissner	2/30/70
Mirabilis L.	1/1/60
Picrasma Blume	1/2/6
Sageretia Brongn.	2/14/35
Sloanea L.	3/14/100
Turpinia Vent.	1/10/30

4. OLD WORLD TROPICS

Alangium Lam.	3/8/17
Albizia Durazz.	2/17/150
Alpinia Roxb.	2/26/250
Asparagus L.	1/24/300
Blumea DC.	1/30/50
Capillipedium Stapf	1/6/10
Cayratia Juss.	3/13/45
Centotheca Desv.	1/1/4
Clausena Burm. f.	1/10/25
Didymocarpus Wallich	1/47/120
Dopatrium Buch.-Ham ex Bentham	1/1/12
Elatostema Forst. & G. Forst.	2/39/200
Embelia Burm. f.	2/20/130
Emilia Cass.	1/4/30
Eulalia Kunth	1/11/30
Euodia Lam.	3/25/45
Galeola Pour.	1/4/25
Gardenia Ellis	1/6/250
Grewia L.	1/27/150
Maesa Forssk.	3/27/200
Mallotus Lour.	4/40/142
Monochoria C. Presl	1/5/6
Mussaenda L.	2/28/200
Osbeckia L.	1/12/100
Pharus P. Browne	1/9/50
Pittosporum Banks ex Gaertner	9/34/150
Pollia Thunb.	1/6/16
Porana Burn. f.	1/14/24
Rostellularia Reichb.	1/3/22

APPENDIX. Continued.

Smithia Aiton	2/4/30
Stephania Lour.	3/30/50
Syzygium Gaertner	1/72/500
Tinospora Miers.	1/7/32
Uraria Desv.	1/9/20
Viscum L.	1/12/100
Zehneria Endl.	1/12/30

5. TROPICAL ASIA AND TROPICAL AUSTRALIA

Aglaia Lour.	1/10/250–300
Ailanthus Desf.	1/5/10
Alyxia R. Br.	1/18/112
Balanophora Forst. & Forst.	3/19/80
Boea Comm. ex Lam.	1/3/17
Cinnamomum Schaeffer	7/46/250
Cleisostoma Blume	1/20/100
Cudrania Trécul.	1/4–8/12
Dendrobium Sw.	2/63/1,400
Dimeria R. Br.	1/4/40
Dunbaria Wight & Arn.	1/7/25
Elaeocarpus L.	2/38/200
Eremochloa Buese.	2/4/10
Eria Lindley	1/36/350
Gastrodia R. Br.	1/3/20
Helicia Lour.	1/18/90
Lagerstroemia L.	2/15/53
Leptopus Decne.	1/8/11
Mazus Lour.	1/22/30
Microcarpaea R. Br.	1/1/1
Nothopanax Miq. emend. Harms	1/3/15
Rabdosia Hassk.	2/77/100
Spathoglottis Blume	1/2/40
Tetrastigma Planchon	3/45/90
Thrixspermum Lour.	1/10/100
Toona M. Roemer	2/3/15
Trichosanthes L.	3/40/55
Wikstroemia Endl.	1/40/70
Zingiber Boehmer	2/14/85

6. TROPICAL ASIA AND TROPICAL AFRICA

Amorphophallus Blume ex Decne.	1/25/100
Arthraxon Pal.	1/6/15
Asystasiella Lindau	1/1/3
Crassocephalum Moench	1/1/30
Debregeasia Gaudich.	2/4/5
Dichrocephala L'Hérit. ex DC.	1/3/10
Dregea E. Meyer	1/5/12
Girardinia Gaudich.	1/7/8
Gynura Cass.	1/15/100
Lecanthus Wedd.	1/3/5
Microstegium Nees	2/10/30
Miscanthus Andersson	1/6/20

APPENDIX. Continued.

Myrsine L.	2/4/7
Neyraudia Hook. f.	1/2/6
Peristrophe Nees	1/5/30
Premna L.	2/45/200
Ricinus L.	1/1/1
Strobilanthes Blume	2/20/250
Taxillus Tieghem	2/15/60
Themeda Forssk.	1/4/10
Thladiantha Bunge	3/29/30
Toddalia Juss.	1/1/1
Tricalysia A. Rich. ex DC.	1/4/100

7. TROPICAL SOUTHEAST ASIA

Adinandra Jack	3/20/80
Aeginetia L.	1/3/10
Aganosma G. Don f.	1/5/15
Aleurites Forst. & G. Forst.	1/1/2
Alniphyllum Matsum.	1/2/2
Altingia Noronha	4/8/12
Amentotaxus Pilger.	1/3/3
Amesiodendron Hu	1/2/2
Brandisia Hook. & Thompson	1/8/11–13
Briggsia Craib.	1/18/20
Broussonetia L'Hérit. ex Vent.	2/5/5
Camellia L.	6/190/220
Campanumoea Blume	2/4/8
Carrierea Franchet	1/2/3
Chirita Buch.-Ham. ex D. Don	1/40/80
Chlamydoboea Stapf	1/2/2
Chloranthus Sw.	3/15/35
Christisonia Gardner	1/1/17
Cipadessa Blume	1/2/3
Coix L.	1/1/5
Collabium Blume	1/2/8
Coptosapelta Korth.	1/1/13
Cyclea Arn. ex Wight	1/13/30
Daphniphyllum Blume	3/10/24
Dichroa Lour.	1/4/13
Distylium Siebold & Zucc.	3/12/18
Engelhardia Leschen. ex Blume	1/6/15
Exbucklandia R. W. Br.	1/2/3
Eurya Thunb.	12/60/130
Gastrochilus D. Don	2/12/22
Globba L.	2/3/70
Gynostemma Blume	1/2/2
Hemiboea C. B. Clarke	4/5/8
Hemsleya Cogn.	2/2/2
Indocalamus Nakai	1/17/20
Kadsura Juss.	1/7/22

APPENDIX. Continued.

Lysidice Hance	1/2/2
Machilus Nees	7/68/100
Manglietia Blume	1/19/32
Michelia L.	2/35/55
Myrioneuron R. Br. ex Kurz.	1/4/15
Neolitsea Merr.	4/40/80
Oenanthe L.	3/11/30
Ophiorrhiza L.	2/25/150
Oreocnide Miq.	1/9/20
Paederia L.	2/11/50
Pellionia Gaudich.	1/16/50
Phoebe Nees	4/34/70
Phyllagathis Blume	1/28/35
Pleione D. Don	1/10/10
Pueraria DC.	1/9/20
Reevesia Lindsey	1/14/18
Sabia Colebr.	1/10/19
Sarcandra Gardner	1/2/3
Sarcococca Lindley	1/8/20
Sarcopyramis Wallich	1/1/1
Schima Reinw. ex Blume	3/9/15
Sindechites Oliver	1/2/3
Sycopsis Oliver	1/2/7
Ypsilandra Franchet	1/4/5
8. NORTH TEMPERATE	
Abies Miller	1/18/50
Acer L.	12/100/200
Aconitum L.	3/160/300
Acorus L.	1/3/3
Actaea L.	1/2/10
Adenocaulon Hook.	1/1/5
Aesculus L.	1/8/13
Agrimonia L.	1/4/15–20
Alisma L.	1/3/10
Allium L.	1/110/700
Alnus Miller	2/8/40
Anaphalis DC.	3/50/100
Androsace L.	1/60/100
Angelica L.	3/26/80
Aquilegia L.	1/9/100
Arenaria L.	1/60/250
Arisaema C. Martius	5/82/150
Artemisia L.	6/170/350
Asarum L.	3/30/70
Berberis L.	7/160/450
Betula L.	3/29/100
Buxus L.	3/11/70
Capsella Medikus	1/1/5
Carpinus L.	8/24/45
Castanea Miller	4/4/12
Cephalanthera Rich.	1/6/14
Cerastium L.	1/22/60
Cercis L.	1/5/7
Chrysosplenium L.	1/42/55

APPENDIX. Continued.

Cimicifuga Wernisch.	1/8/15
Circaea L.	4/7/8
Cirsium Miller	3/50/200
Clinopodium L.	3/11/20
Coptis Salisb.	1/6/15
Coriaria L.	1/3/15
Cornus L.	5/22/45
Corydalis DC.	1/200/320
Corylus L.	2/7/15
Cotoneaster Medikus	5/45/50
Cryptotaenia DC.	1/1/5
Cupressus L.	1/5/13
Cynoglossum L.	2/10/50–60
Cypripedium L.	1/23/40
Deutzia Thunb.	1/40/50–60
Deyeuxia Clarion ex Pal.	3/43/100
Elaeagnus L.	5/10/45
Epilobium L.	8/37/165
Fagus L.	3/5/10
Fraxinus L.	2/25/70
Habenaria Willd.	1/70/500
Halenia Borkh.	1/2/103
Heracleum L.	1/23/60
Iris L.	1/40/300
Juglans L.	1/4/15–20
Leontopodium R. Br.	1/41/50
Ligusticum L.	1/30/60
Lilium L.	2/40/80
Listera R. Br.	7/18/30
Lonicera L.	6/100/180
Malus Miller	4/22/25
Malva L.	3/4/40
Melandrium Röhl.	1/33/100
Mentha L.	1/6/25
Monotropa L.	1/1/5
Morus L.	3/6/10
Myrica L.	1/4/50
Orobanche L.	1/25/150
Ostrya Scop.	1/4/10
Oxytropis DC.	1/30/300
Parnassia L.	1/36/50
Pedicularis L.	5/350/600
Philadelphus L.	1/15/65
Pinus L.	2/22/95
Platanthera Rich.	2/40/200
Polygonatum Miller	2/35/55
Populus L.	1/25/35
Potentilla L.	4/90/500
Primula L.	2/300/500
Prunella L.	1/3/7
Prunus L.	17/140/200
Pyrola L.	2/23/25
Quercus L.	14/70/450
Rhodiola L.	2/75/90
Rhododendron L.	16/650/800

APPENDIX. Continued.

Rhus L.	3/6/250
Ribes L.	3/45/150
Rosa L.	2/82/200
Rubia L.	2/17/60
Sabina Miller	1/14/50
Sagina L.	1/4/30
Salix L.	10/200/500
Sambucus L.	2/5/20
Saussurea DC.	5/320/403
Saxifraga L.	1/180/370
Sedum L.	4/125/350
Solidago L.	1/1/100
Sorbus L.	8/55/85
Spiraea L.	6/50/100
Spiranthes Rich.	1/2/40
Streptopus Michaux	1/5/10
Thalictrum L.	5/67/150
Tilia L.	1/35/50–80
Trifolium L.	1/7/300
Ulmus L.	1/23/45
Urtica L.	1/15/50
Vaccinium L.	5/47/450
Valeriana L.	4/24/200
Veratrum L.	1/13/25
Veronica L.	1/64/250
Viburnum L.	11/74/150
Vicia L.	1/40/150
Vitis L.	7/25/60–70

9. EASTERN ASIA AND NORTH AMERICA

Abelia R. Br.	2/6/30
Aletris L.	1/13/25
Ampelopsis Michaux	1/1/2
Amphicarpaea Elliot ex Nutt.	1/1/3
Antenoron Raf.	2/2/4
Apios Fabr.	1/6/10
Aralia L.	3/30/35–40
Astilbe Buch.-Ham ex D. Don	1/15/25
Berchemia Necker ex DC.	2/16/22
Cacalia L.	1/50/80
Castanopsis Spach.	7/60/122
Caulophyllum Michaux	1/1/3
Cladrastis Raf.	1/5/6
Cleyera Thunb.	3/11/17
Disporum Salisb. ex D. Don	3/10/20
Hamamelis L.	1/2/6
Hugeria Small	1/2/3
Hydrangea L.	15/45/80
Illicium L.	1/21/42
Itea L.	1/12/15
Leibnitzia Cass.	1/3/7
Lespedeza Michaux	4/25/40
Liquidambar L.	2/2/5

APPENDIX. Continued.

Liriodendron L.	1/1/2
Lithocarpus Blume	9/70/300
Lyonia Nutt.	3/6/35
Magnolia L.	4/30/90
Mahonia Nutt.	4/40/80
Meehania Britton	3/5/7
Muhlenbergia Schreber	2/6/100
Nyssa L.	1/6/10
Osmanthus Lour.	2/15/17
Panax L.	1/6/8
Parthenocissus Planchon	4/9/15
Photinia Lindley	4/40/60
Phryma L.	1/1/1
Pieris D. Don	1/6/10
Pogonia Juss.	1/3/10
Sassafras Nees & Eberm.	1/2/3
Schisandra Michaux	1/19/25
Smilacina Desf.	1/18/30
Tiarella L.	1/1/5
Toxicodendron Miller	3/15/20
Trachelospermum Lemaire	6/10/20
Tsuga Carrière	3/5/14
Veronicastrum Moench	1/14/20

10. OLD WORLD TEMPERATE

Adenophora Fischer	2/49/60
Ajuga L.	1/18/40–50
Anthriscus Pers.	1/2/20
Asyneuma Griseb. & Schenk.	1/1/51
Carpesium L.	4/10/20
Cucubalus L.	1/1/1
Daphne L.	2/35/70
Dendranthema Des Moul.	1/17/30
Dipsacus L.	2/8/15
Elsholtzia Willd.	4/33/35
Epimedium L.	2/14/21
Fagopyrum Miller	2/8/15
Hemerocallis L.	1/11/15
Inula L.	1/20/200
Lactuca L.	1/40/118
Leontice L.	1/2/3–5
Ligularia Cass.	3/100/150
Ligustrum L.	5/38/51
Lotus L.	1/3/100
Melissa L.	1/3/4
Nerium L.	1/2/4
Origanum L.	1/1/15–20
Paris L.	3/16/20
Peucedanum L. (also Africa)	2/30/170
Phlomis L.	1/43/100
Pyracantha M. Roemer	3/7/10

APPENDIX. Continued.

Roegneria K. Koch	1/70/90
Scopolia Jacq.	1/2/5
Tamarix L.	1/18/60
Torilis Adan.	1/2/12
Zelkova Spach	2/4/6–7
11. TEMPERATE ASIA	
Bergenia Moench	1/6/10
Campylotropis Bunge	1/50/65
Kalimeris Cass.	1/7/20
Myriactis Less.	2/5/10
Trigonotis Steven	2/32/50
Tripterospermum Blume	6/20/35
12. MEDITERRANEAN, WESTERN TO CENTRAL ASIA, AND NORTH TO CENTRAL ASIA	
Pistacia L.	1/2/10
13. EASTERN ASIA	
Acanthopanax Miq.	7/27/35
Actinidia Lindley	4/52/54
Ainsliaea DC.	2/45/70
Akebia Decne.	2/2/5
Amitostigma Schltr.	1/20/23
Aucuba Thunb.	1/3/4
Aulacolepis Hacket	1/2/4
Beesia Balf. f. & W. W. Sm.	1/2/2
Belamcanda Adanson	1/1/2
Bletilla Reichb. f.	1/4/6
Bothrispermum Bunge	1/5/5
Cardiocrinum Lindley	2/2/3
Caryopteris Bunge	1/12/15
Catenaria Bentham	1/1/1
Cephalotaxus Sieb. & Zucc.	3/7/9
Cercidiphyllum Sieb. & Zucc.	1/1/1
Choerospondias B. L. Burtt & A. W. Hill	1/1/1
Codonopsis Wallich	2/39/50
Corylopsis Sieb. & Zucc.	5/20/30
Cremastra Lindley	1/2/7
Decaisnea Hook. & Thomson	1/1/1
Deinostema Yamazaki	1/1/2
Dendrobenthamia Hutch.	2/12/12
Dichocarpum W. T. Wang & Hsiao	1/9/18
Disporopsis Hance	1/4/4
Enkianthus Lour.	3/7/10
Euscaphis Sieb. & Zucc.	1/1/1
Gardneria Wallich	1/5/6

APPENDIX. Continued.

Ginkgo L.	1/1/1
Helwingia Willd.	2/4/4
Hemiphragma Wallich	1/1/1
Holboellia Wallich	2/11/12
Hosta Tratt.	1/3/40
Houttuynia Thunb.	1/1/1
Hovenia Thunb.	1/3/3
Idesia Maxim.	1/1/1
Kalopanax Miq.	1/1/1
Kerria DC.	1/1/1
Keteleeria Carrière	1/2/2
Kummerowia Schindler	1/2/2
Liriope Lour.	2/6/8
Loropetalum R. Br. ex Reichb.	1/2/3
Lycoris Herbert	2/15/20
Lysionotus D. Don	1/29/31
Macleaya R. Br.	1/2/2
Maddenia Hook. & Thomson	2/4/5
Mosla Buch.-Ham. ex Maxim.	3/11/22
Nandina Thunb.	1/1/1
Nonocnide Blume	1/2/4
Neillia D. Don	1/10/12
Nothosmyrnium Miq.	1/2/2
Ophiopogon Ker-Gawler	7/40/60
Oreocharis Bentham	2/20/20
Patrinia Juss.	3/13/20
Paulownia Sieb. & Zucc.	2/6/17
Perilla L.	1/1/1
Phtheirospermum Fisch. & Meyer	2/3/7
Phyllostachys Sieb. & Zucc.	3/40/50
Pileostegia Hook. & Thomson	1/2/3
Platycarya Sieb. & Zucc.	2/2/2
Pogonatherum Pal.	1/2/2
Prinsepia Royle	1/4/4
Pternopetalum Franchet	3/25/27
Pterocarya Kunth	1/9/10
Pterostyrax Sieb. & Zucc.	2/2/4
Reineckea Kunth	1/1/1
Rhaphiolepis Lindley	1/7/14
Rhynchospermum Reinw.	1/1/2
Rohdea Roth	1/1/1
Sargentodoxa Rehd. & Wils.	1/1/1
Schizophragma Sieb. & Zucc.	3/6/8
Semiaquilegia Makino	1/1/7

APPENDIX. Continued.

Serissa Comm. ex Juss.	1/2/3
Sinarundinaria Nakai	2/10/23
Sinomenium Diels	1/1/1
Siphocranion Kudo	2/2/2
Siphonostegia Bentham	2/2/3
Spatholirion Ridley	1/3/3
Spodiopogon Trin.	1/6/10
Stachyurus Sieb. & Zucc.	4/8/10
Stauntonia DC.	4/22/25
Stranvaesia Lindley	1/4/5
Tetracentron Oliver	1/1/1
Toricellia DC.	1/2/3
Tricyrtis Wallich	1/5/11
Triplostegia Wallich ex DC.	1/2/2
Tripterygium Hook. f.	1/4/4
Tubocapsicum Makino	1/2/2
Tupistra Ker-Gawler	2/16/25
Weigela Thunb.	1/4/12
Youngia Cass.	1/40/50
14. ENDEMIC TO CHINA	
Asteropyrum J. R. Drumm. & Hutch.	1/2
Bostrychanthera Bentham	1/2
Bretschneidera Hemsley	1/1
Camptotheca Decne.	1/1
Chimonanthus Lindley	1/3
Clematoclethra Maxim.	1/1
Cunninghamia R. Br.	1/2
Cyclocarya Iljinsk.	1/1
Davidia Baillon	1/1
Dickinsia Franchet	1/1
Dipteronia Oliver	1/2
Dysosma Woodson	3/7
Emmenopterys Oliver	1/1
Eomecon Hance	1/1
Eucommia Oliver	1/1
Eurycorymbus Hand.-Mazz.	1/1
Hanceola Kudo	1/8
Latouchea Franchet	1/1
Pteroceltis Maxim.	1/1
Rostrinucula Kudo	1/2
Sinojohnstonia Hu	1/2
Thyrocarpus Hance	1/3
Whytockia W. W. Sm.	1/2